Soil Organic Carbon Sequestration in the Southeastern USA:

Potential and Limitations

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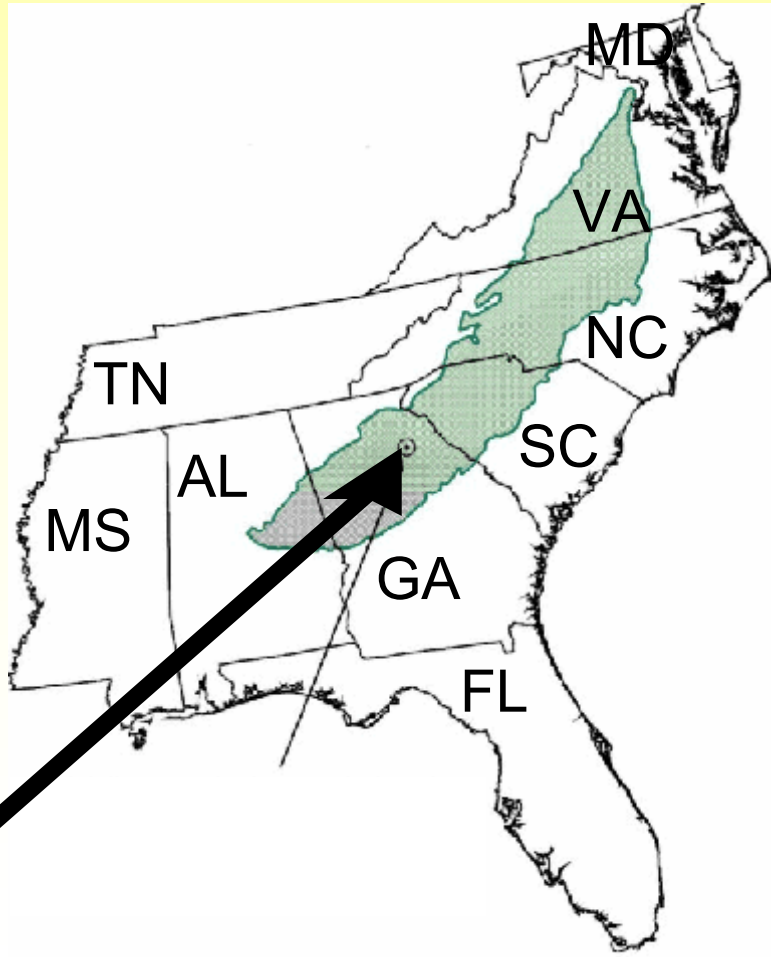
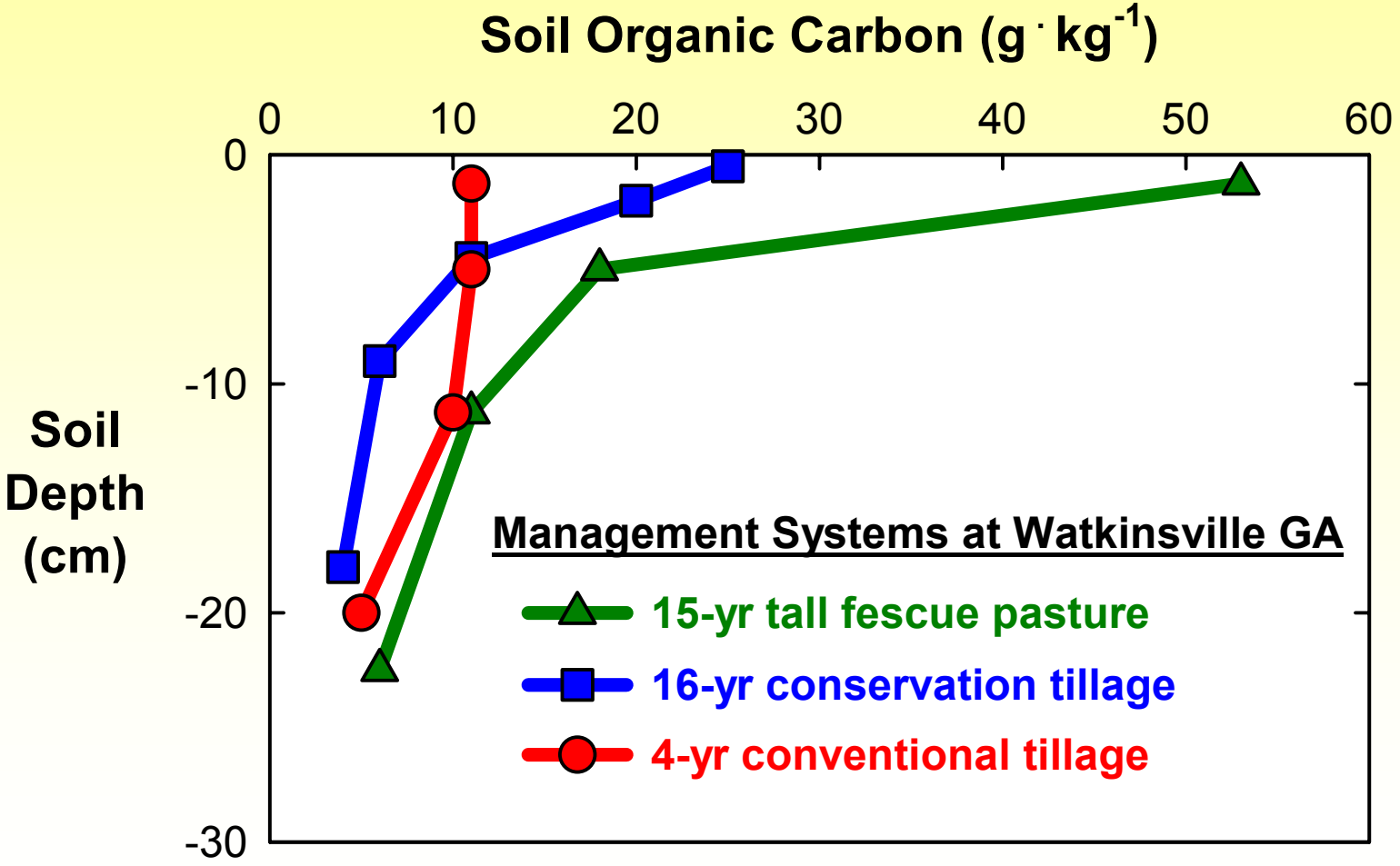


Soil Carbon Sequestration

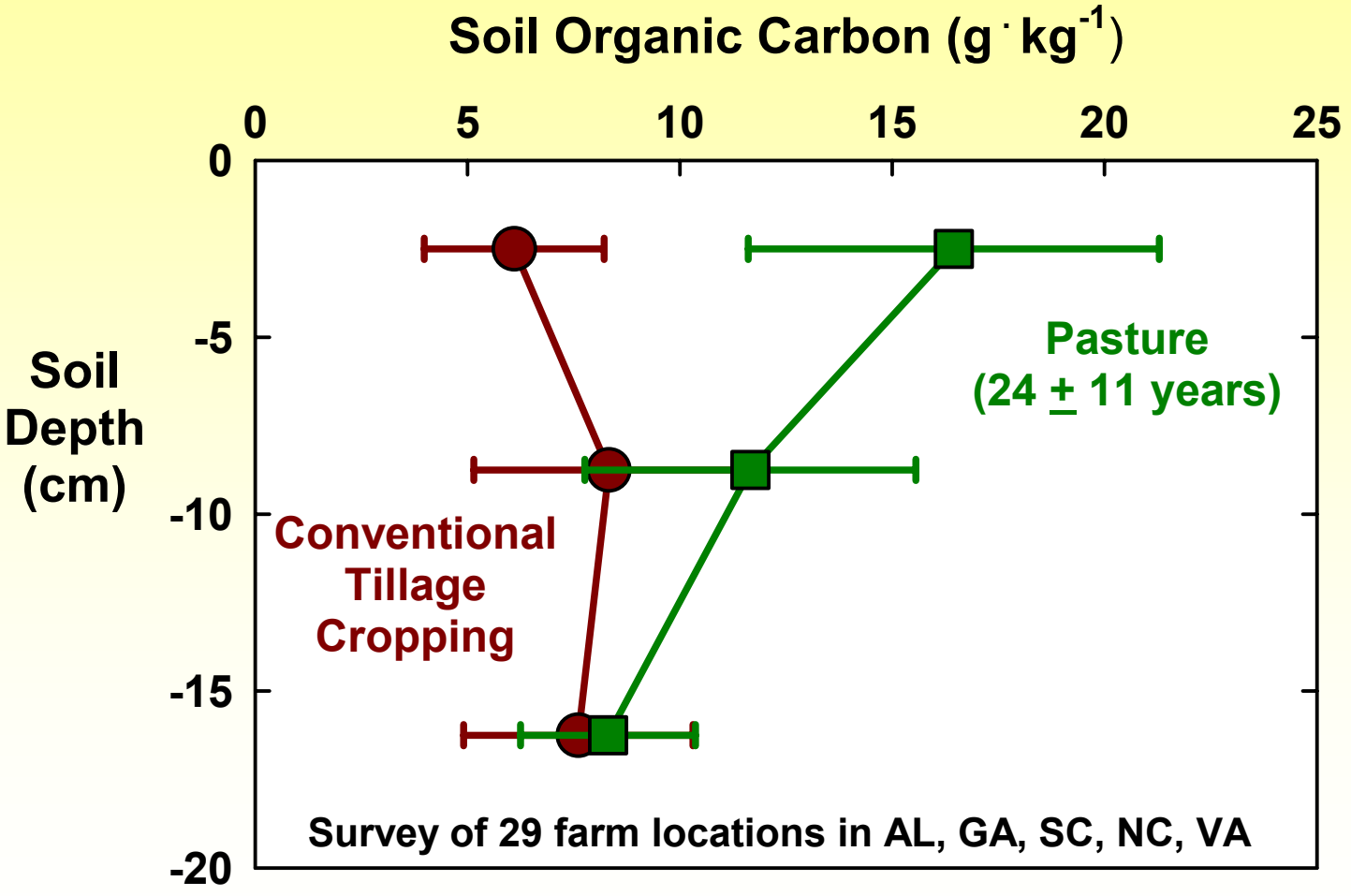
Depth distribution of soil organic C



From Schnabel et al. (2001) Ch. 12, Pot. U.S. Grazing Lands Sequester C, Lewis Publ.

Soil Carbon Sequestration

Calculation by relative difference



Sequestration of SOC (Mg ha^{-1} yr^{-1})

0.53 **

0.17 **

0.05 ns

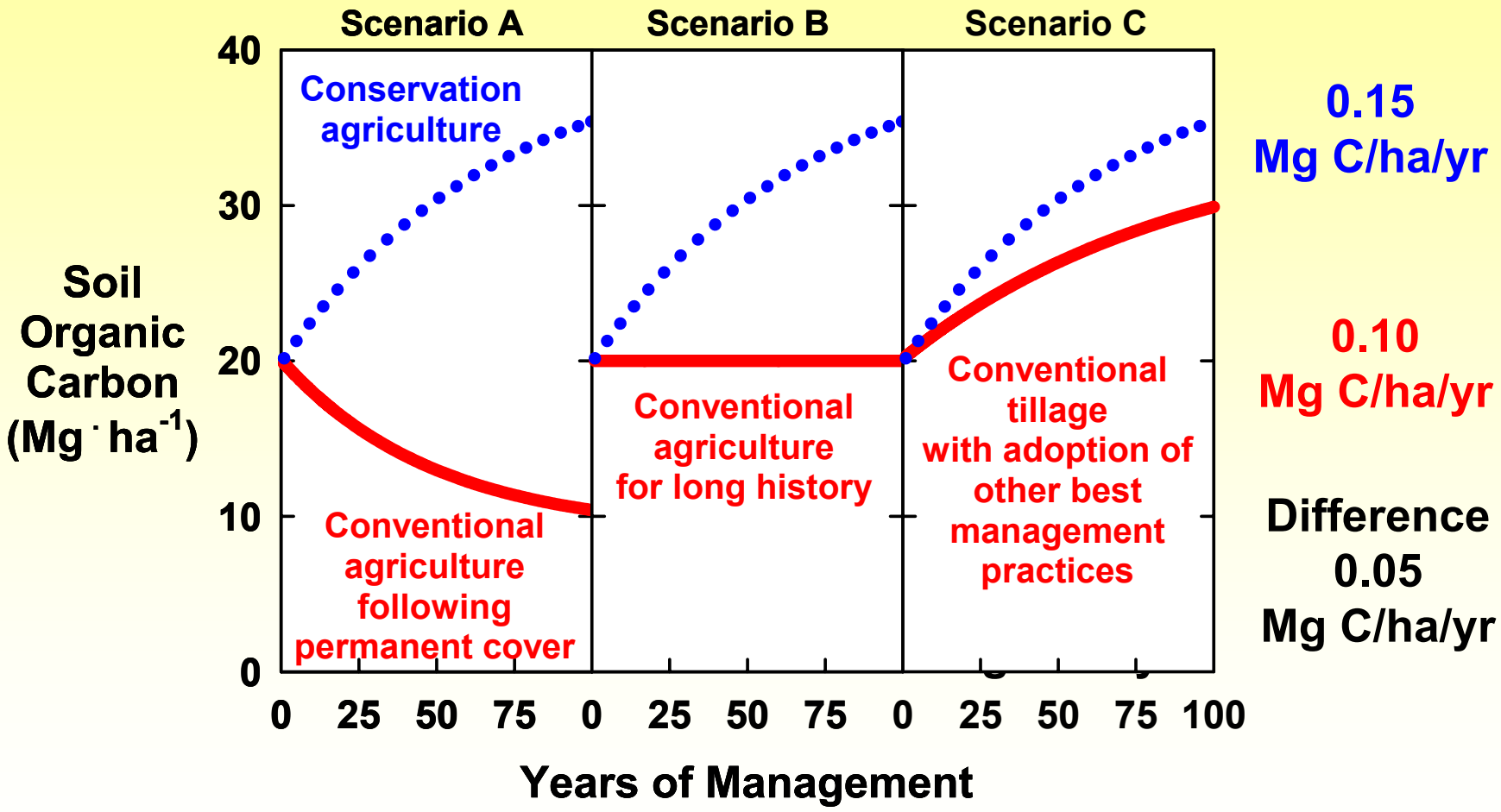
0-20 cm

0.74 **

Data from Causarano et al. (2008) Soil Sci. Soc. Am. J. 72:221-230

Soil Carbon Sequestration

Calculation by change with time

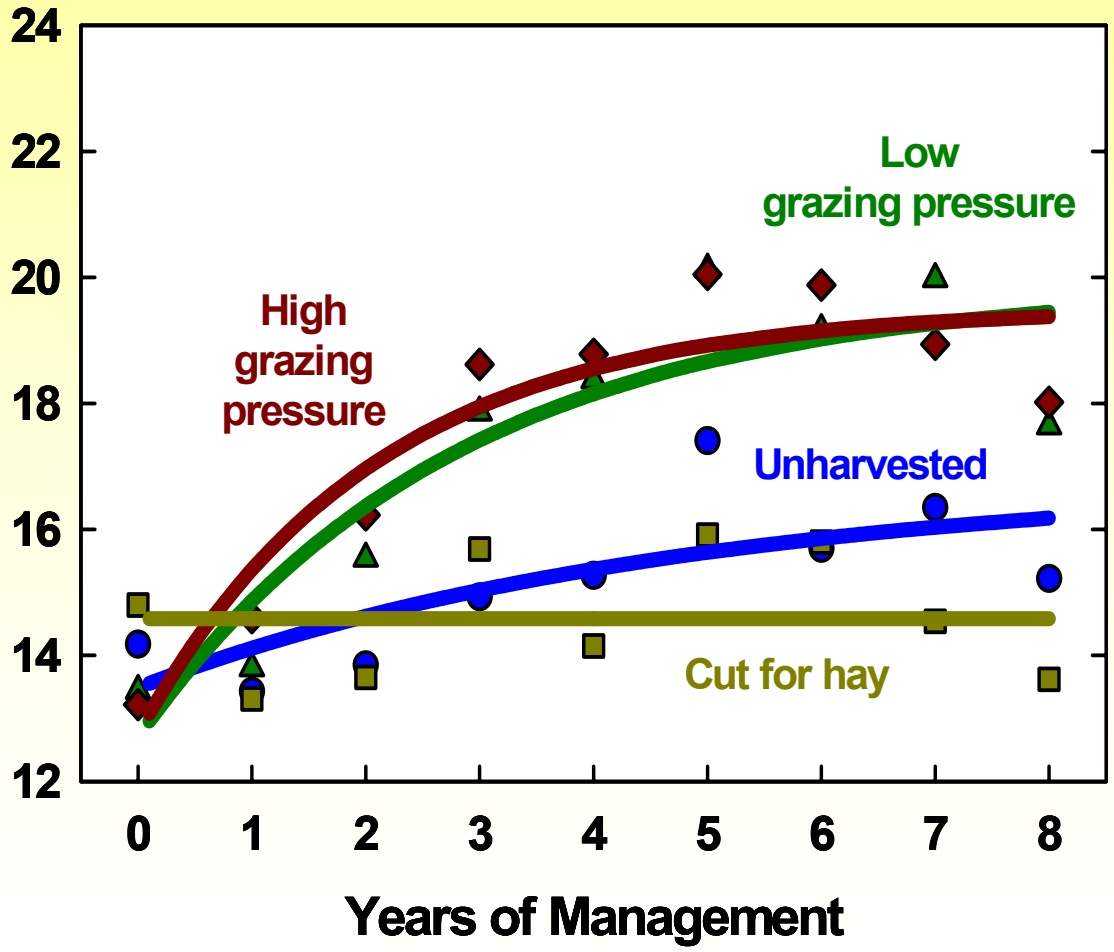


Temporal and comparative approaches of value; in combination best!

Soil Carbon Sequestration

Calculation by change with time

Establishment of bermudagrass pasture following long-term cropping in Georgia USA (16 °C, 1250 mm)



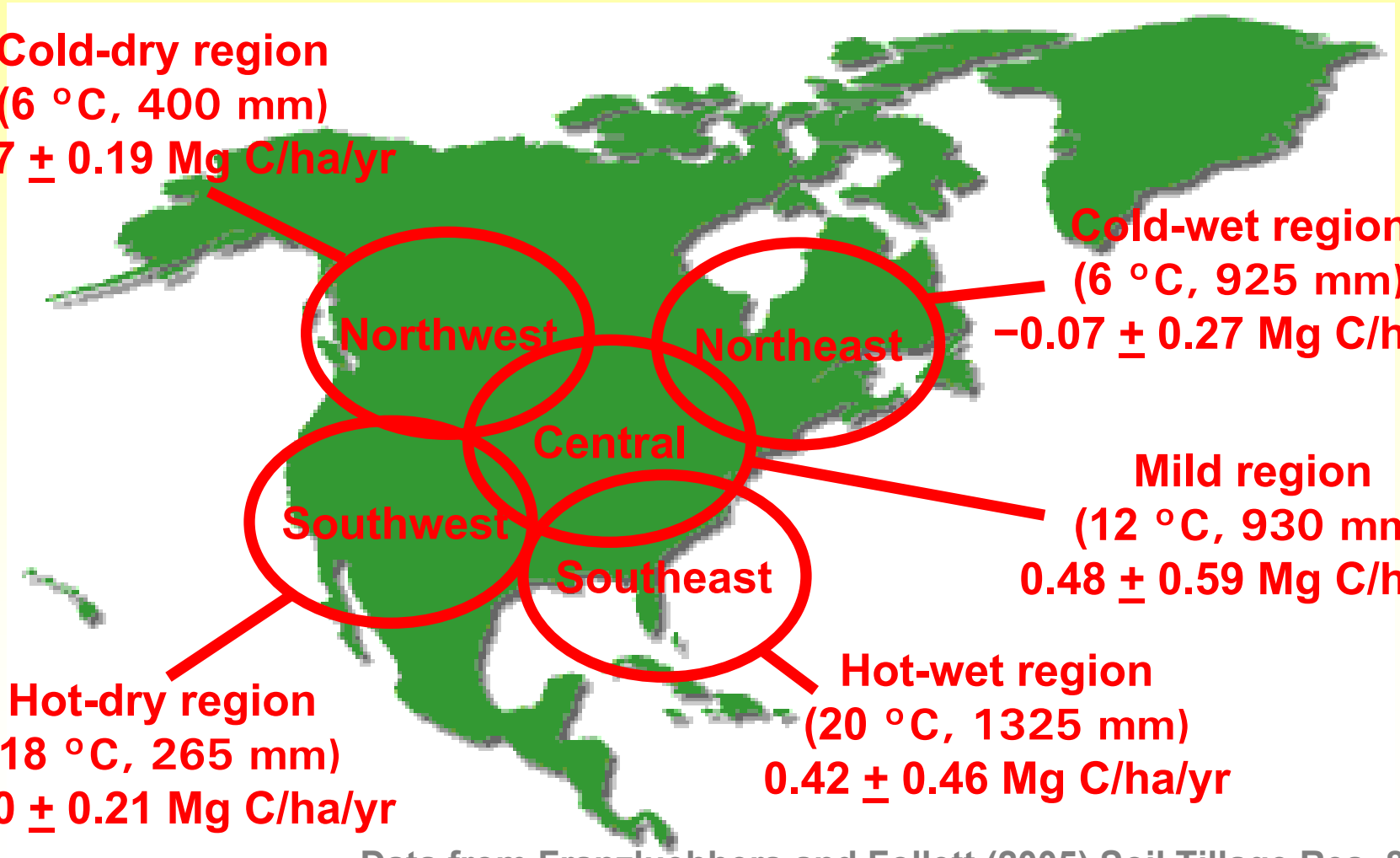
Soil C sequestration (Mg ha^{-1} yr^{-1}) (0-5 yr):

Hayed	0.30
Unharvested	0.65
Grazed	1.40

Franzluebbers et al. (2001) Soil Sci. Soc. Am. J. 65:834-841 and unpublished data

Soil Carbon Sequestration

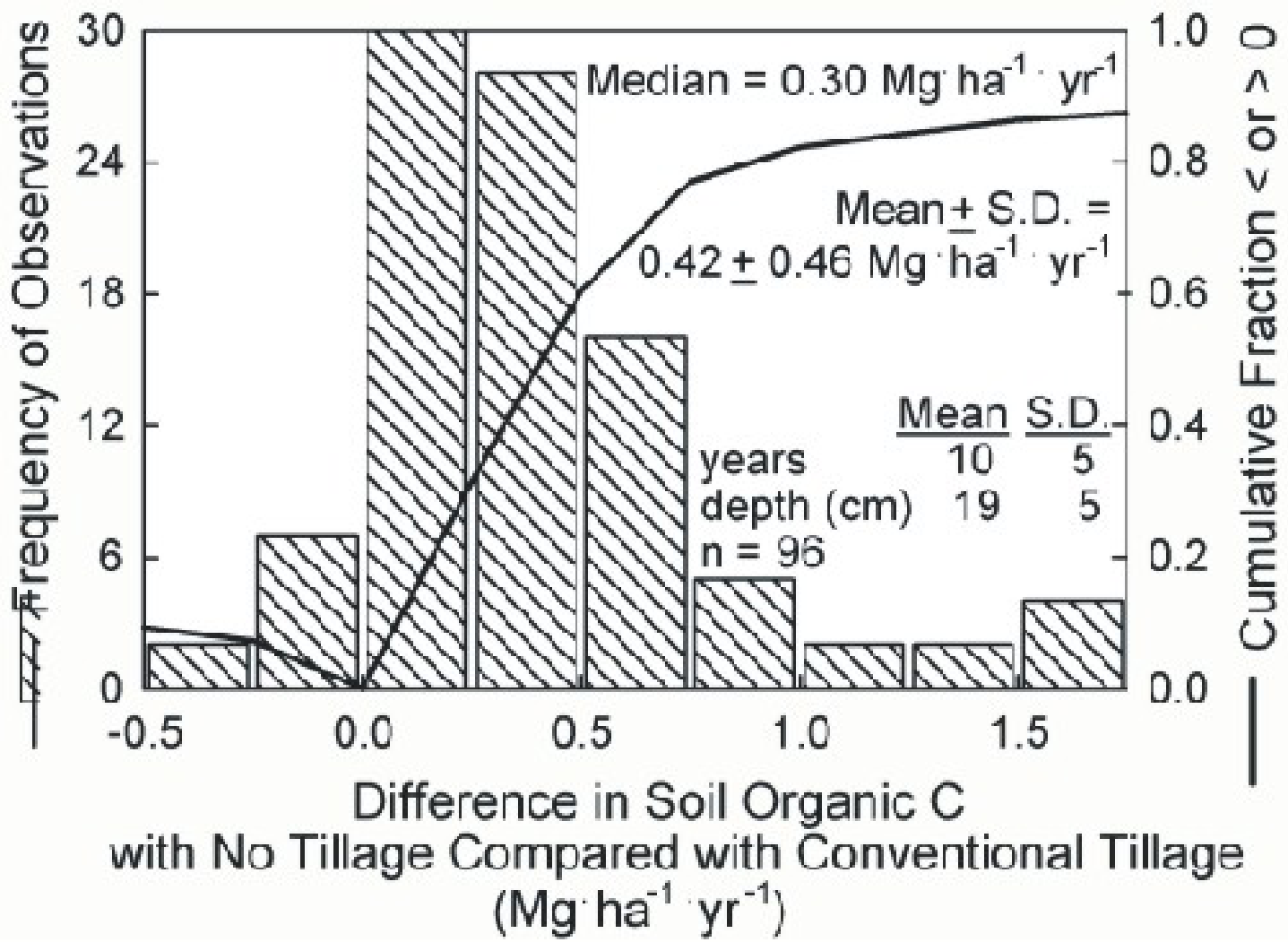
In the USA and Canada, conservation-tillage cropping can sequester an average of 0.33 Mg C/ha/yr



Data from Franzluebbers and Follett (2005) Soil Tillage Res. 83:1-8

Soil Carbon Sequestration

Literature review from the southeastern USA



Franzluebbers (2005) Soil Tillage Res. 83:120-147.

Soil Carbon Sequestration

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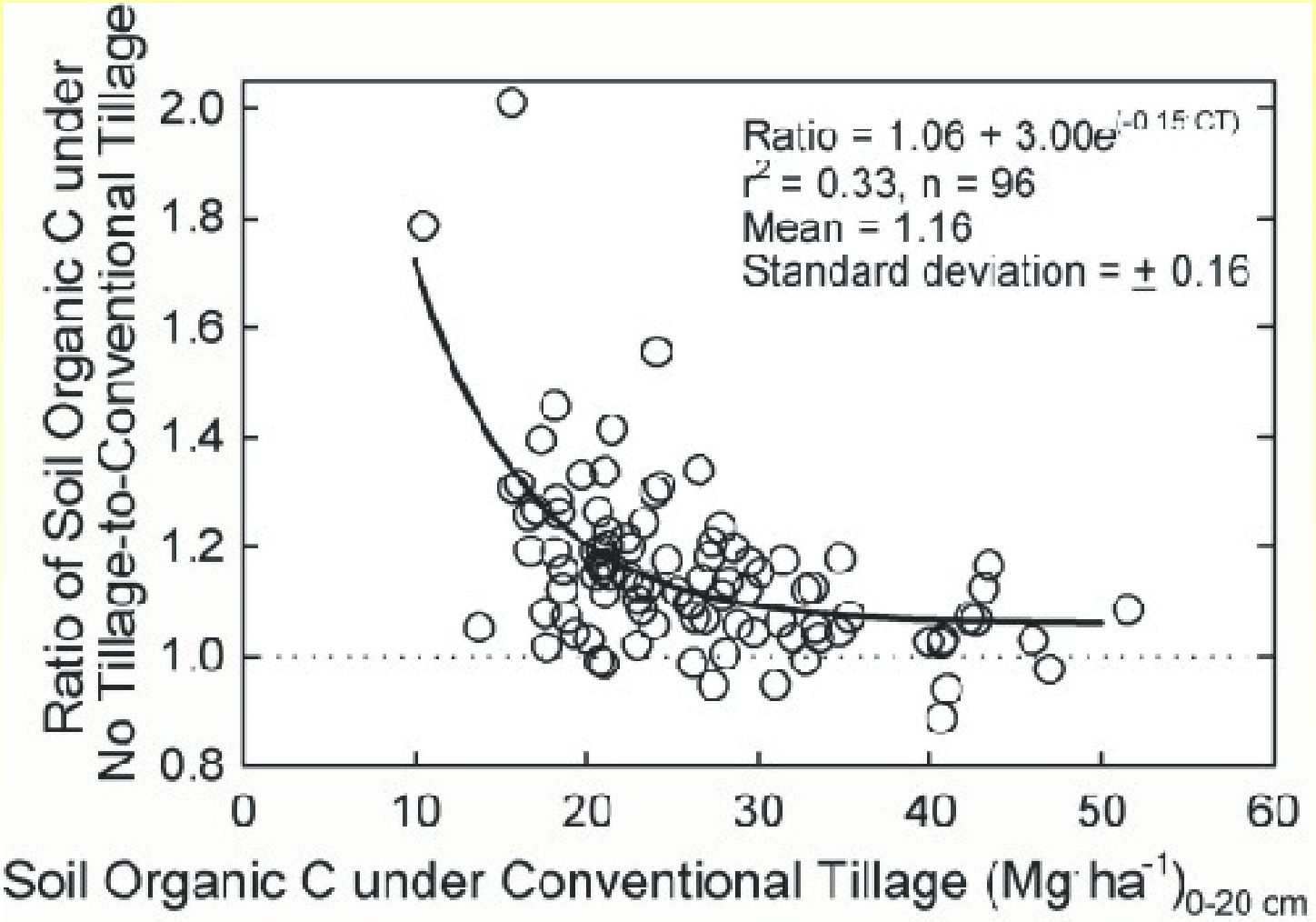


Franzluebbers (2005) Soil Tillage Res. 83:120-147.

Soil Carbon Sequestration

Impact of cover cropping in the southeastern USA

Photos of 2 no-tillage systems in Virginia USA

Soil Organic Carbon Sequestration in the Southeastern USA

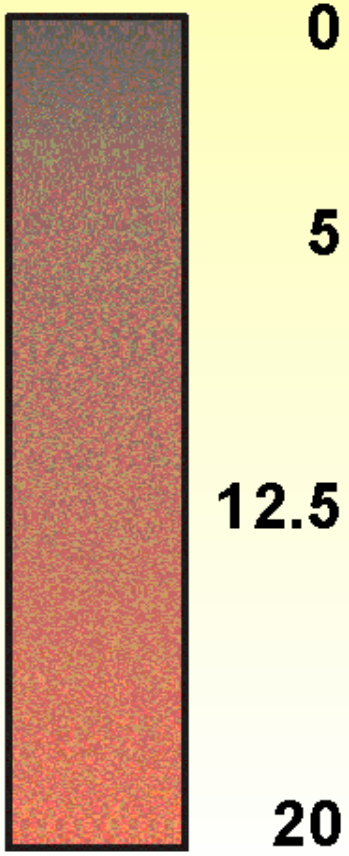
0.28 ± 0.44 Mg C/ha/yr (without cover cropping)

0.53 ± 0.45 Mg C/ha/yr (with cover cropping)

Franzluebbers (2005) Soil Tillage Res. 83:120-147.

Soil Carbon Sequestration

Stratification ratio of soil organic C



- ✔ Concentration of soil property at 0-5-cm depth divided by concentration at 12.5-20-cm depth.
- ✔ Soil property near the bottom of the 'plow layer' should reflect an inherent characteristic to normalize each soil.

Franzluebbers (2002) Soil Till. Res. 66:95-106

Soil Carbon Sequestration

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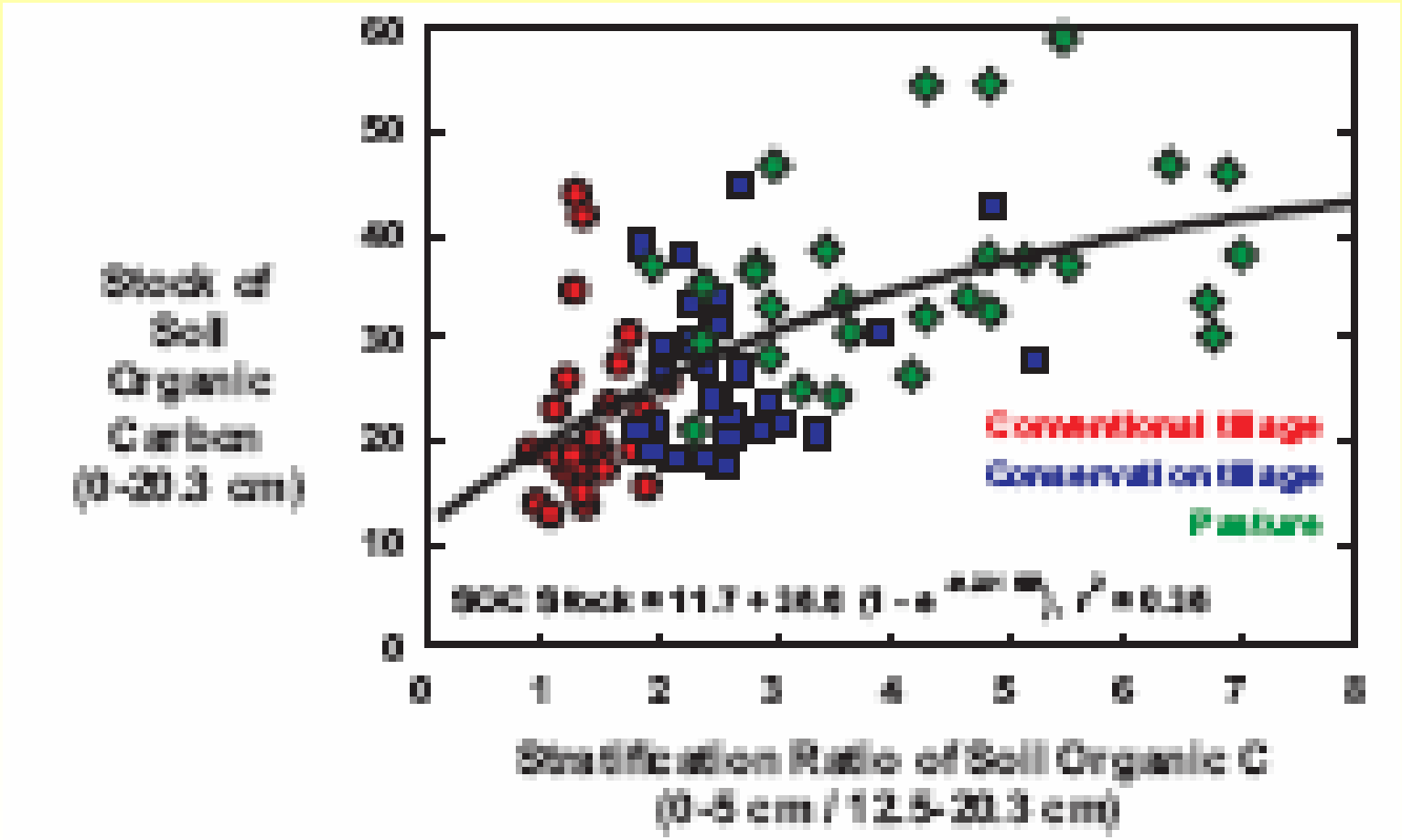

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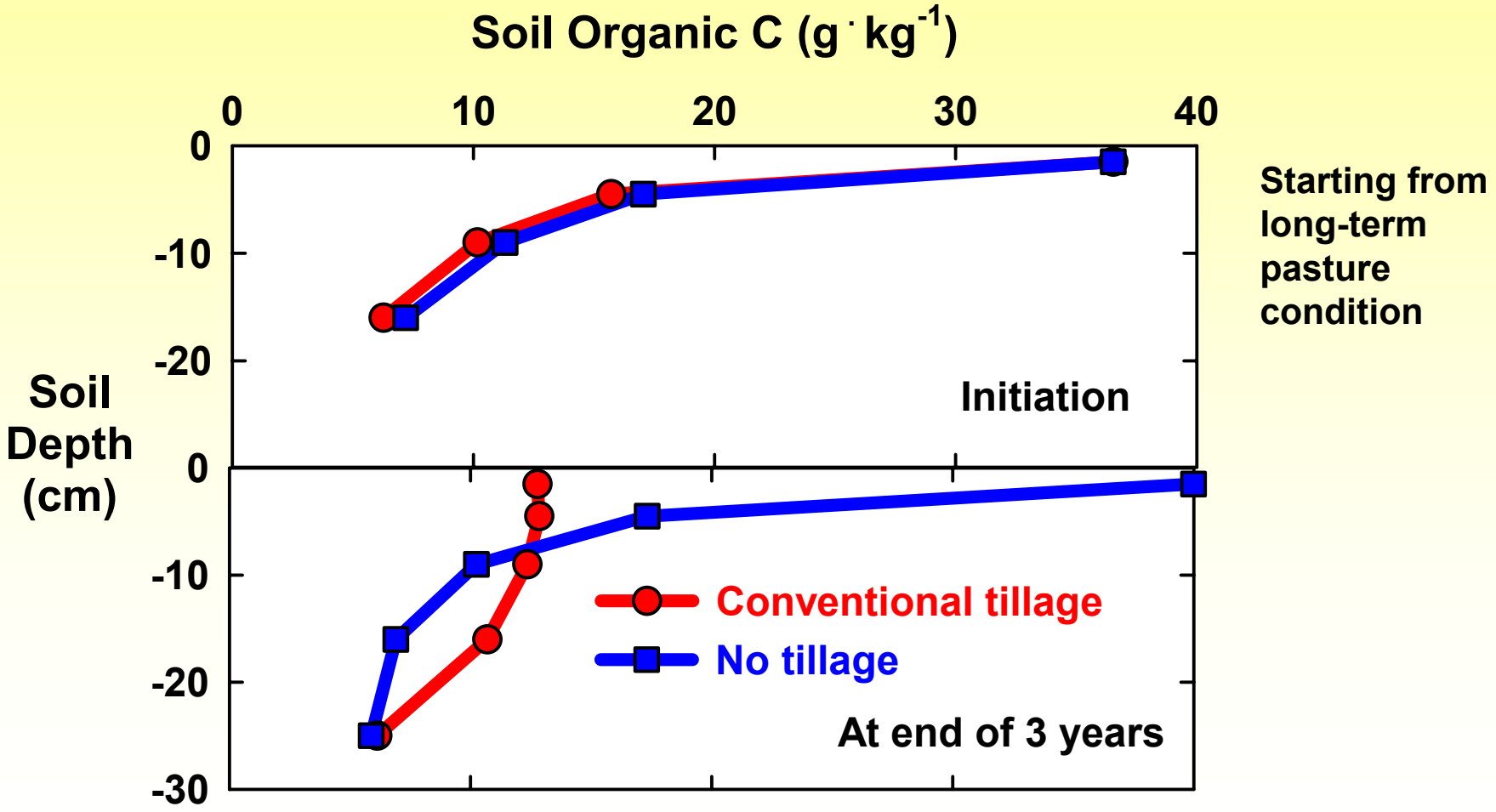
Soil Carbon Sequestration

Influence of tillage system following pasture



Franzluebbers and Stuedemann (2008) Soil Sci. Soc. Am. J. 72:613-625

Soil Carbon Sequestration

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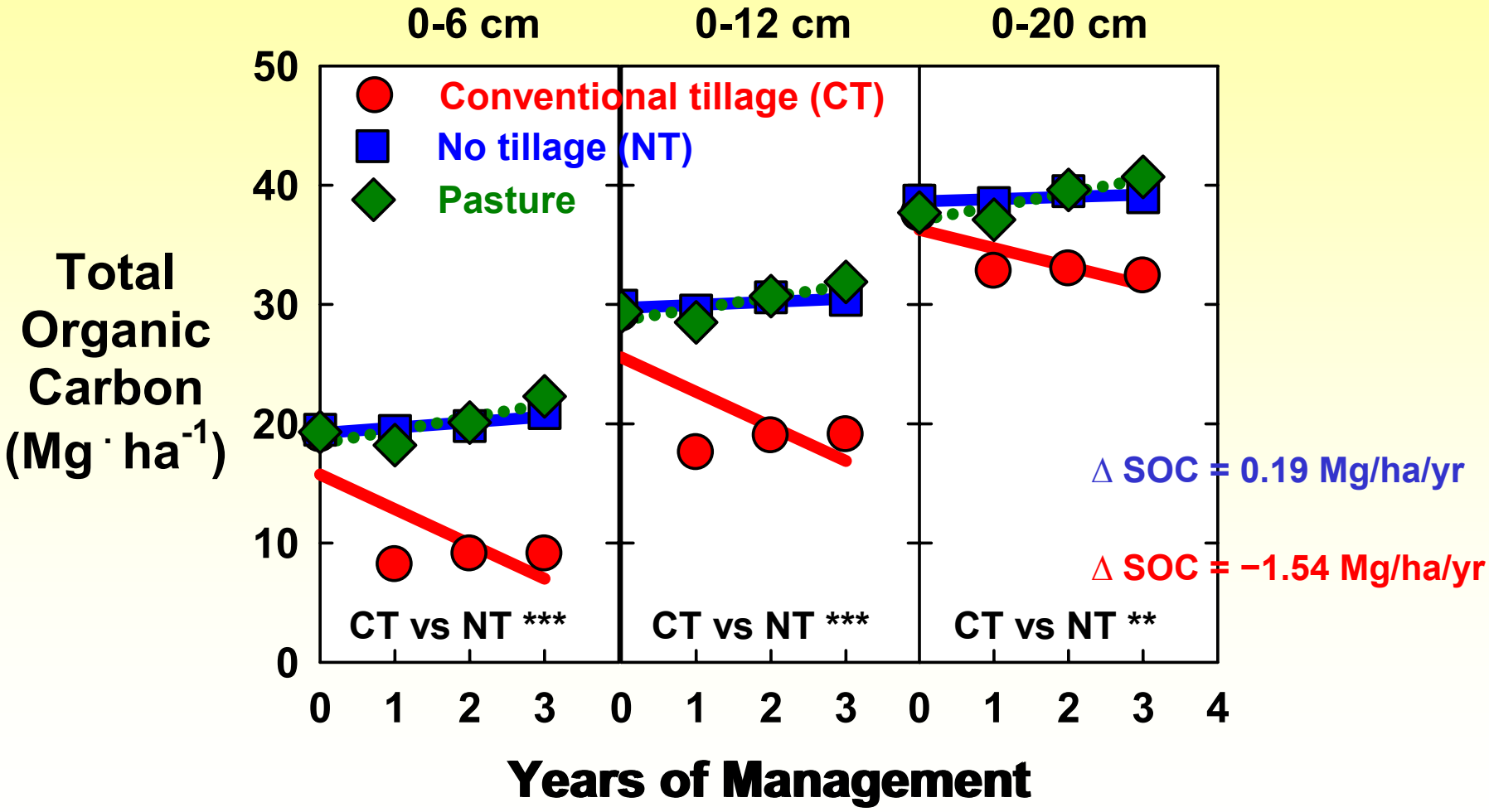
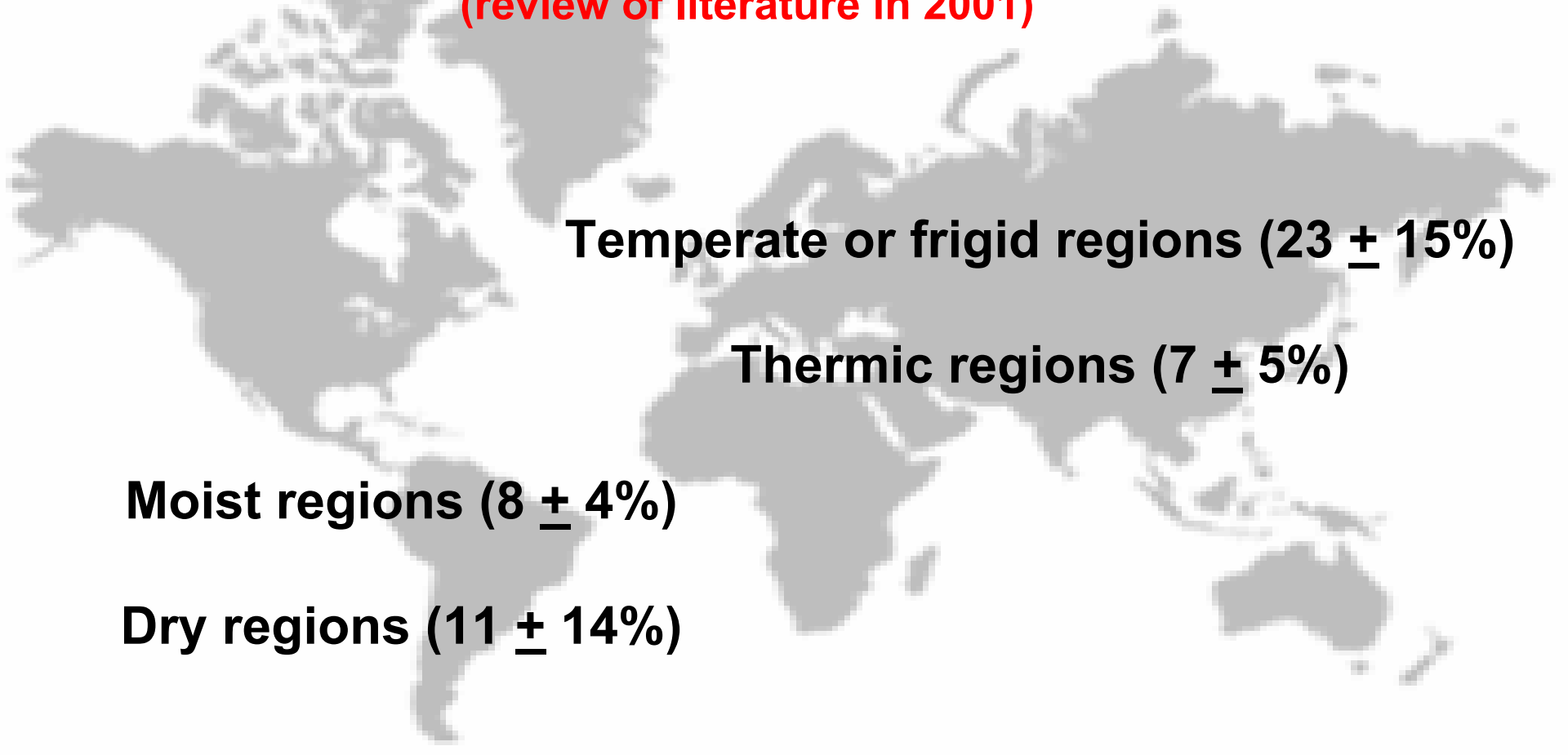


Franzluebbers and Stuedemann (2008) Soil Sci. Soc. Am. J. 72:613-625

Soil Carbon Sequestration

Influence of animal manure application dependent on climate

Percentage of carbon applied as manure retained in soil (review of literature in 2001)



Temperate or frigid regions (23 ± 15%)

Thermic regions (7 ± 5%)

Moist regions (8 ± 4%)

Dry regions (11 ± 14%)

Soil Carbon Sequestration

Integration of crops and livestock

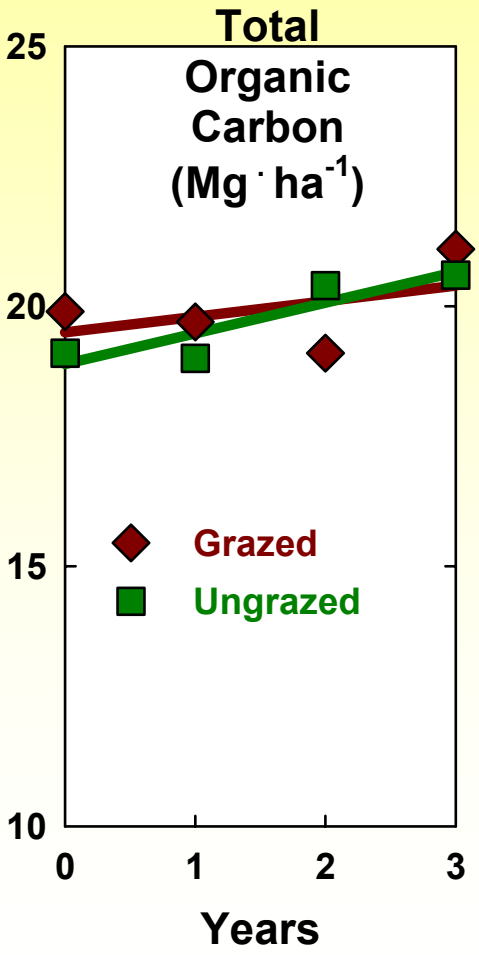
✓ **Opportunities exist to capture more carbon from crop and grazing systems when the two systems are integrated:**

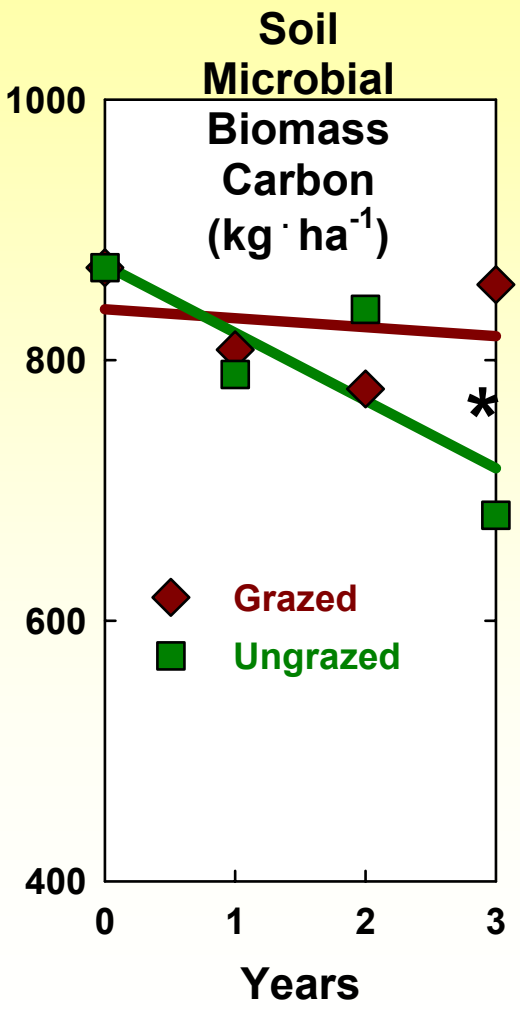
- **Utilization of ligno-cellulosic plant materials by ruminants**
- **Manure deposition directly on land**
- **Weeds can be managed with management rather than chemicals**

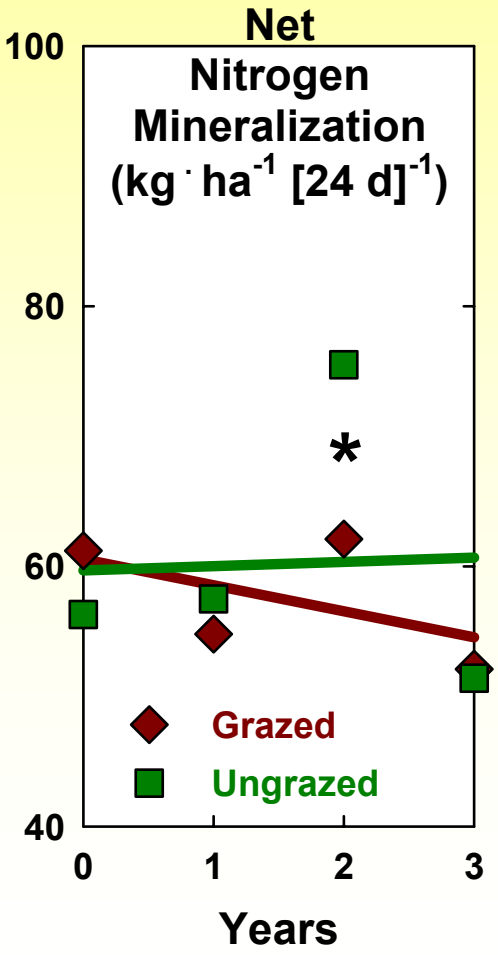
Franzluebbers and Stuedemann (2008)
Soil Sci. Soc. Am. J. 72:613-625

Soil Carbon Sequestration

Grazing of cover crops under no tillage (0-6 cm)







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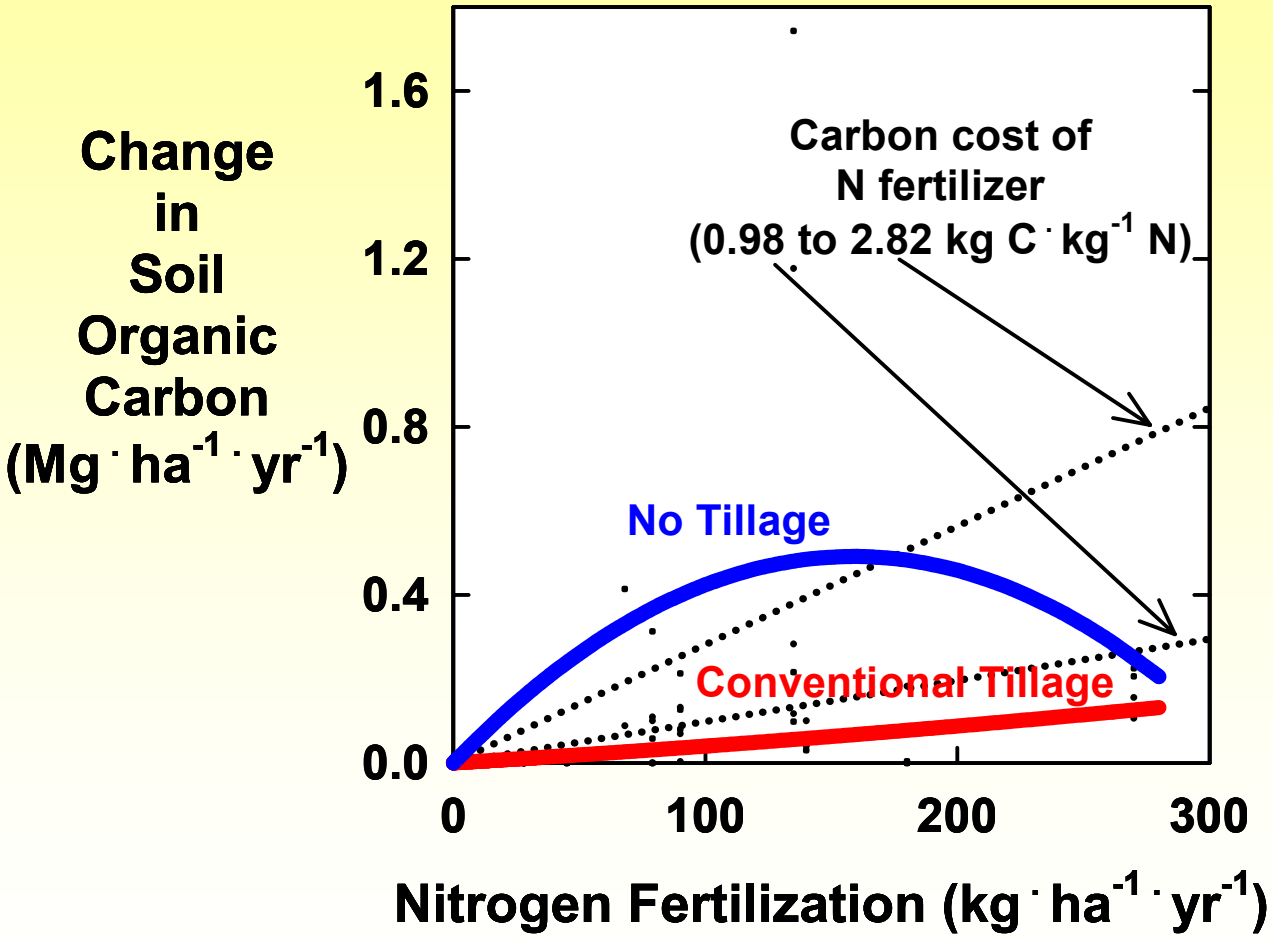
Soil Carbon Sequestration

Nitrogen fertilization effect

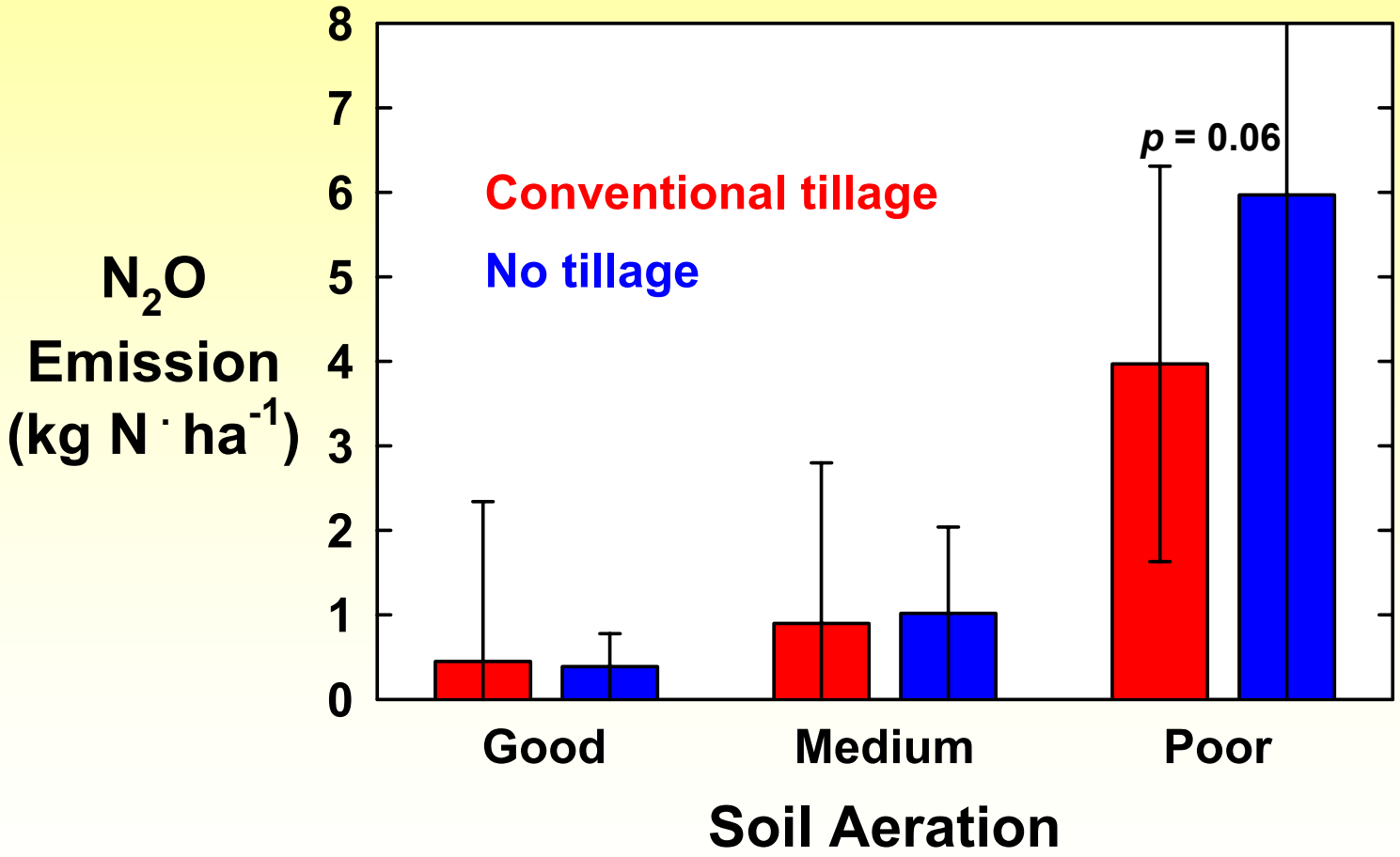


1 kg N_2O-N ha^{-1} = 0.13 Mg C ha^{-1}

Franzluebbers (2005) Soil Tillage Res. 83:120-147

Nitrous Oxide Emission

Interaction of tillage with soil type



45 site-years of data reviewed
Brazil, Canada, France, Japan,
New Zealand, United Kingdom, USA

Rochette (2008) Soil Till. Res. 101:97-100

Soil Carbon Sequestration

Influence of crop residue removal

At end of 7 years

Response 0-20-cm depth		Silage Crop Removal		
	Initially	0.5 yr^{-1}		1-2 yr^{-1}
Bulk density (Mg m^{-3})	1.43	1.37	ns	1.39
Macroaggregate stability (g g^{-1})	0.74	0.87	*	0.81
Soil organic C (mg g^{-1})	11.7	14.3	*	12.5

On-farm research
North Carolina Piedmont
Corn silage each year vs corn silage less often

Franzluebbers and Brock (2007)
Soil Till. Res. 93:126-137

Off-Site Impacts

Water quality implications

Pennsylvania

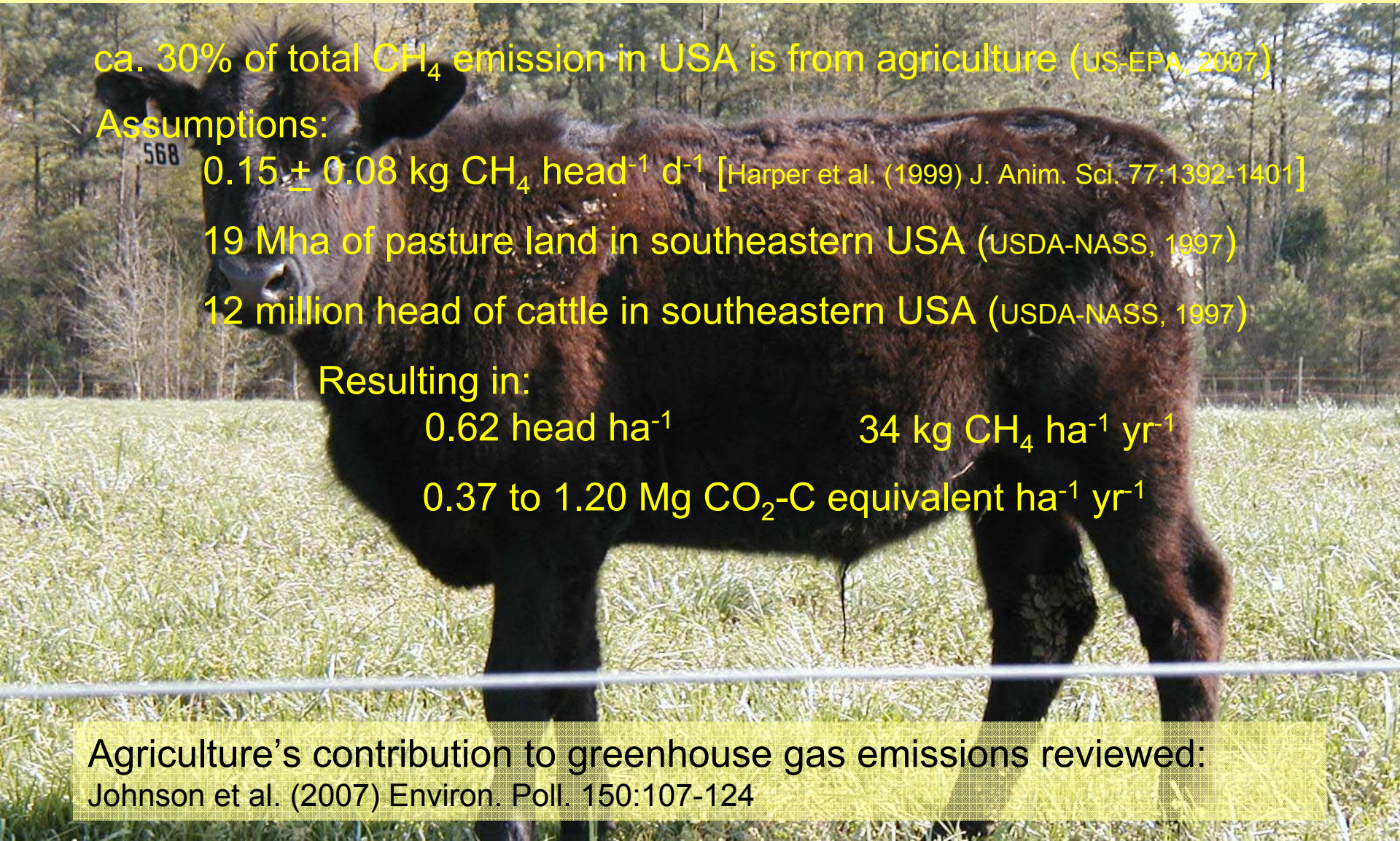
Land use	Soil (g/kg – 0-5 cm depth)		Runoff loss (kg/ha)		
	Organic C	Mehlich-3 P	Sediment	Dissolved P	Total P
CT crop	13.7	0.32	767	0.02	0.52
NT crop	25.2	0.33	312	0.03	0.27
Grass	16.6	0.40	104	0.03	0.19

Oklahoma

Land use	Water runoff (mm/yr)	Runoff loss (kg/ha/yr)				
		Sediment	Nitrate N	Total N	Dissolved P	Total P
CT wheat	61	6515	1.3	15.0	0.2	2.8
NT wheat	111	625	1.4	7.2	0.7	1.4
Grass	48	100	0.1	1.2	0.1	0.1

Data from Sharpley and Kleinman (2003) J. Environ. Qual. 32:2172-2179
and Sharpley and Smith (1994) Soil Tillage Res. 30:33-48

Methane Emission



ca. 30% of total CH_4 emission in USA is from agriculture (US-EPA, 2007)

Assumptions:

0.15 ± 0.08 kg CH_4 $head^{-1}$ d^{-1} [Harper et al. (1999) J. Anim. Sci. 77:1392-1401]

19 Mha of pasture land in southeastern USA (USDA-NASS, 1997)

12 million head of cattle in southeastern USA (USDA-NASS, 1997)

Resulting in:

0.62 head ha^{-1}

34 kg CH_4 ha^{-1} yr^{-1}

0.37 to 1.20 Mg CO_2-C equivalent ha^{-1} yr^{-1}

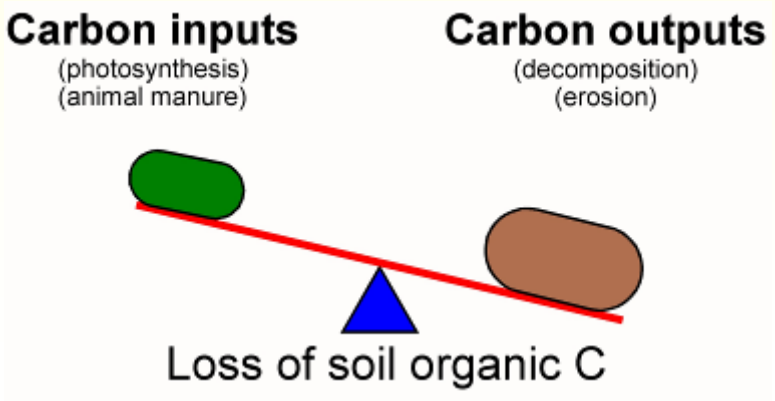
Agriculture's contribution to greenhouse gas emissions reviewed:
Johnson et al. (2007) Environ. Poll. 150:107-124

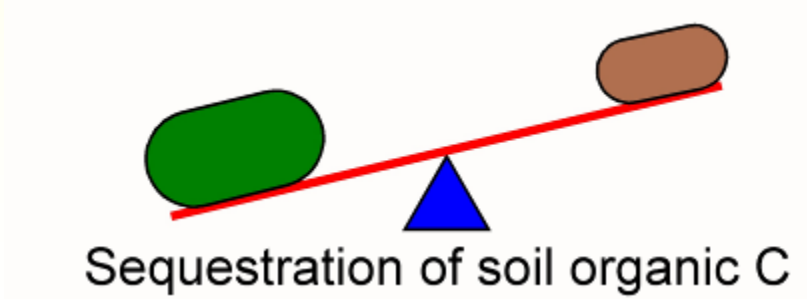
Soil Carbon Sequestration

Summary

Soil organic carbon can be sequestered with adoption of conservation agricultural practices

- ✓ Enhanced soil fertility and soil quality
- ✓ Mitigation of greenhouse gas emissions
- ✓ Soil surface change is most notable
- ✓ Long-term changes are most scientifically defensible





Soil Carbon Sequestration

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Cotton Incorporated
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